WEARABLE VOICE-INDUCED VIBRATION OR SILENT GESTURE SENSOR

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application is a nonprovisional of and claims the benefit under 35 U.S.C. § 119(e) of U.S. Provisional Patent Application No. 62/852,481, filed May 24, 2019, entitled "SMI-Based Wearable Voice-Induced Vibration and Silent Gesture Sensor," the contents of which are incorporated herein by reference as if fully disclosed herein.

FIELD

[0002] The present disclosure generally relates to wearable electronic devices. The wearable electronic devices are equipped with self-mixing interferometry sensors for detection of user inputs and/or user input commands. The self-mixing interferometry sensors may detect the user inputs by detecting skin deformations or skin vibrations at one or more locations on a user's head. The skin deformations or skin vibrations may be caused by a user's voiced or silent speech or head motion.

BACKGROUND

[0003] Wearable electronic devices, such as smart watches or headphones, are often configured to receive user inputs or commands by detecting a user's voice, or a user's press at a button or on an input screen. The voiced input command may be received by a microphone of the wearable electronic device.

[0004] Each of these input processes has potential limitations. Voice recognition software must distinguish the user's or wearer's voice from background noise or voices of others, and press or force inputs require a user's hands to be free. Also, a user may be unable to input a command to the wearable electronic device without being heard.

SUMMARY

[0005] This summary is provided to introduce a selection of concepts in a simplified form that are further described below in the Detailed Description section. This summary is not intended to identify key features or essential features of the claimed subject matter, nor is it intended to be used as an aid in determining the scope of the claimed subject matter.

[0006] Disclosed herein are wearable electronic devices and user input detection systems for wearable electronic devices. The wearable electronic devices (or "wearable devices", or "devices") may be equipped with one or more self-mixing interferometry sensors operable to detect a user input or user command by detecting skin deformation or skin vibrations at a location on the user, such as on the head of the user.

[0007] More specifically, described herein is a wearable device that includes: a frame configured to attach the wearable device to a user; a self-mixing interferometry sensor mounted to the frame and configured to emit a beam of light; and a command interpreter configured to receive a self-mixing interferometry signal from the self-mixing interferometry sensor. The frame may be configured to direct the beam of light toward the head of the user. The self-mixing interferometry signal may include skin deformation information. The command interpreter may be configured to identify a command encoded in the skin deformation information.

[0008] In additional and/or alternative embodiments, the skin deformation information may include skin vibration information. The device may be configured as an earbud that also includes a microphone and an in-ear speaker. The self-mixing interferometry sensor may direct the beam of light toward a location in an ear of the user, and the command interpreter may be operable to identify a voiced command of the user using the skin vibration information.

[0009] In additional and/or alternative embodiments, the skin deformation information may include skin vibration information. The device may be configured as an eyeglasses set, with the self-mixing interferometry sensor mounted to an arm of the eyeglasses set. The self-mixing interferometry sensor may direct the beam of light toward a location proximate to the temporal bone of the user. The command interpreter may be operable to identify a voiced command of the user based on the skin vibration information.

[0010] In additional and/or alternative embodiments, skin deformation information may include temporomandibular joint movement information. The device may be configured as a headphone, with at least one self-mixing interferometry sensor mounted on the headphone to direct the beam of light toward a location on the user's head proximate to the temporomandibular joint of the user. The command interpreter may be operable to identify the temporomandibular joint movement information as a silent gesture command of the user.

[0011] In additional and/or alternative embodiments, the skin deformation information may include temporomandibular joint movement information. The device may be configured as a visual display headset, with at least a first and a second self-mixing interferometry sensor. The first self-mixing interferometry sensor may direct its beam of light toward a location on the user's head proximate to a temporomandibular joint of the user, and the second self-mixing interferometry sensor may direct its beam of light toward a location on the user's head proximate to the parietal bone. The command interpreter may be configured to receive respective first and second self-mixing interferometry signals from the first and second self-mixing interferometry sensors. The command interpreter may be configured to detect a silent gesture command of the user using the first self-mixing interferometry signal and to detect a voiced command of the user using the second self-mixing interferometry signal.

[0012] Also described herein is a device that may include: a head-mountable frame that is configured to be worn by a user; a self-mixing interferometry sensor mounted to the head-mountable frame and operable to emit a beam of light toward a location on the user's head; a microphone; a command interpreter configured to receive an output of the microphone and recognize a voiced command of the user; and a bioauthentication circuit configured to authenticate the voiced command using a self-mixing interferometry signal of the self-mixing interferometry sensor.

[0013] In additional and/or alternative embodiments, the self-mixing interferometry signal may include skin deformation information. The bioauthentication circuit may be operable to detect, using at least the skin deformation information, that the user was speaking during a time interval of the received output of the microphone and